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SUBJECT: **ARCHITECTURAL TECHNICAL GUIDE 0016 (January 1, 2005)**
Summary of Thermal Performance Construction Standards and Eligible
Locations for Air Conditioning for New and Existing Construction Financed by
the USDA/Rural Housing Service's Single Family Housing (SFH) Programs

The purpose of this Architectural Technical Guide (ATG) is to summarize current thermal design requirements regarding new and existing Section 502 housing financed by USDA/Rural Development. The Agency's requirements for thermal performance in new and existing construction are split (based on construction type and new versus existing) among parts of three regulatory standards as discussed at length in Rural Development Instruction 1924-A, Exhibit D. This sometimes causes confusion among residential designers, builders, dealer-contractors, housing manufacturers, guarantee lenders, and home purchasers. This ATG is intended to discuss key definitions; outline current USDA/Rural Development regulatory requirements; and discuss usage of the Council of American Building Officials, "*Model Energy Code*", 1992 Edition, which comprises the contemporary thermal standard for "stick-built" and "modular" Single Family Housing construction. This ATG is organized under the following major headings:

- 1 Applicable Thermal Performance Design Standards
- 2 Certification Requirements
- 3 Recommendations for Thermal Design Upgrading of Existing Construction,
- 4 Council of American Building Officials (CABO), *Model Energy Code*, 1992 Edition
- 5 Cooling Design Requirements, and
- 6 USDA/Rural Development Employee Responsibilities.

APPLICABLE THERMAL PERFORMANCE DESIGN STANDARDS

Three different thermal design standards apply to the Section 502 (Direct and Guarantee) Rural Housing Program financed construction, depending on the method of construction and whether new or existing construction is involved, as follows:

All **newly constructed "stick-built" and "modular" housing** should be designed to and certified to the Council of American Building Officials (CABO) "*Model Energy Code*" (1992 Edition). [Ref.: Subparagraph 1924.5 (f) (1) (iii)].

All **newly constructed "manufactured" housing** should be designed to and inspected/certified to the "*Federal Manufactured Housing Construction and Safety Standard*" (FMHCSS), a nationwide U.S. Department of Housing and Urban Development (HUD) standard which includes thermal design criteria and independent

inspection agency requirements. Also reference [Architectural Technical Guide \(ATG\) 0004, Change in the Thermal Performance Construction Standard for New Manufactured Housing Financed by Rural Housing Service Single Family Housing \(SFH\) and Multi-Family Housing \(MFH\) Programs](#), for more information on this subject.

All **existing “stick-built” and “modular” single family housing** (irregardless of the method of construction) should be upgraded to the design criteria of Rural Development Instruction 1924-A, Exhibit D, Subparagraph IV. B. or C. [Ref.: Rural Development Instruction 1924-A, Exhibit D, Subparagraph II.]. Also reference [Architectural Technical Guide \(ATG\) 0015, Thermal Performance Supplement for Existing Construction Financed by the USDA/Rural Housing Service’s Section 502 and Section 504 Single Family Housing Programs](#), for more information on this subject.

"Stick-built" refers to non-factory-built construction, designed to conform to the International Conference of Building Officials (ICBO) and/or the International Code Council (ICC) building, plumbing, and mechanical codes.

"Modular" refers to factory-built construction designed to conform to the (ICBO) and/or the International Code Council (ICC) building, plumbing, and mechanical codes.

"Manufactured" refers to factory-built construction designed to conform to the U.S. Department of Housing and Urban Development, *"Federal Manufactured Home Construction and Safety Standard"*.

Following is a summary of the applicability of the three separate thermal standards to the different types of construction currently funded by the USDA/Rural Development [Ref.: Rural Development Instruction 1924-A, Exhibit D, Subparagraph II. and Exhibit J, Subparagraph Part A, V. B. 2., Rural Development Handbook, HB-1-3550, 9.16 C, and the Rural Development Special Procedure Notice issued on October 4, 1999]:

New Construction:

| | |
|----------------------------------|---|
| New "stick-built" construction: | CABO, <i>"Model Energy Code"</i> , 1992 Edition |
| New "modular" construction: | CABO, <i>"Model Energy Code"</i> , 1992 Edition |
| New "manufactured" construction: | <i>"Federal Manufactured Home Construction and Safety Standard"</i> |

Existing Construction:

| | |
|---------------------------------------|---|
| Existing "stick-built" construction: | Rural Development Instruction 1924-A, Exhibit D, <i>"Thermal Performance Construction Standards"</i> , Minimum Requirements for Existing Construction |
| Existing "modular" construction: | Rural Development Instruction 1924-A, Exhibit D, <i>"Thermal Performance Construction Standards"</i> , Minimum Requirements for Existing Construction |
| Existing "manufactured" construction: | Not applicable: units must be "new", meaning less than one year old and not previously occupied |

Also of note, the USDA/Rural Development, Colorado State Office, has also determined that mechanical cooling systems may also be financed in certain areas of Colorado where the number of cooling degree days warrant it. This is discussed in more detail under the topic, “Cooling Design Requirements”, below.

CERTIFICATION REQUIREMENTS

A certification protocol, which involves a written certification by a non-USDA/Rural Development technical party, should be followed to verify thermal design conformance. It takes on two forms, depending on the method of construction. It is important to keep in mind that one of the original intentions of this process was to alleviate the burden of USDA/Rural Development employees having to perform involved technical analysis of the validity of thermal design proposals.

A completed Form RD 1924-25, "*Plan Certification*", which contains a section regarding thermal performance plans, specifications, and calculations, should be obtained for all **new stick-built and modular housing construction** [Ref.: Subparagraph 1924.5 (f) (1) (iii) (F) of the Instruction]. This form is actually a multi-purpose certification form which pertains to building safety, seismic, and other concerns as well as thermal issues for housing construction projects. It should be accomplished by an appropriate technical party, as discussed in more detail in Subparagraph 1924.5 (f) (1) (iii) (A) of the Instruction.

The certification regime for **new manufactured housing construction** is quite different. The provisions of the "*Federal Manufactured Home Construction and Safety Standard*" require that the home manufacturer affix a U.S. Department of Housing and Urban Development (HUD), Zone 3, "*Comfort Heating and Comfort Cooling*" thermal sticker to each manufactured home for sale in Colorado. This label is normally affixed near the circuit breaker panel location within the home.

RECOMMENDATIONS FOR THERMAL DESIGN UPGRADING OF EXISTING CONSTRUCTION

Existing housing being considered for funding under the authorities of the Direct and Guarantee Section 502 Rural Housing Program should conform to Rural Development Instruction 1924-A, Exhibit D, Subparagraphs IV. B. or C., as qualified by Subparagraph 1980.313 (f) of the Instruction for Guarantee loanmaking.

Existing residences pose special difficulties for thermal upgrading due to the wide variety of construction methods employed in the past and to the relative inaccessibility of many ceiling, wall, and floor assemblies. Except in the instances of easily accessible door, window, attic, crawlspace, and basement components, thermal upgrading would normally be financially unfeasible and could actually impose safety hazards (i.e. by superimposing additional loading scenarios beyond original structural design limitations). Thermal insulation, itself, is usually not relatively heavy, but insulation concealment systems (i.e. furring, gypsum drywall, etc.) are. Subparagraph IV. B. notes imply that thermal upgrades should pretty much be limited to readily accessible assemblies, without the need for installing additional structures.

Even if spaces are accessible for insulation upgrading without installing additional structures, attention should be given to some additional related considerations: adequate space ventilation requirements and protecting pipes from freezing. Adding attic insulation, for example, could effectively close off soffit vents if the installer were not attentive. Likewise, insulating only the

ground floor level flooring system perimeter area could place water supply piping below the first floor level in a condition subject to freezing in certain instances.

Following are some suggestions for upgrading thermal resistance in existing construction which take structural and cost effectiveness considerations into account. They should be evaluated in conjunction with Rural Development Instruction 1924-A, Exhibit D, Subparagraph B, which offers additional guidance. The Winter Heating Degree Day map for the State of Colorado, provided as Exhibit A to this ATG, should also be consulted.

| | <u>Direct Loan Program</u> | <u>Guarantee Loan Program</u> |
|--|--|--|
| Attic areas and suspended: ceiling areas at attics: | <p>Increase attic insulation to a minimum total of R=32 (areas under 6,000 WHDD**) or</p> <p>R=38 (areas over 6,000 WHDD**) and provide minimum minimum attic ventilation requirements*** requirements***</p> | <p>Increase attic insulation to a minimum total of R=32 under 6,000 WHDD**) or</p> <p>R=38 (areas over 6,000 WHDD**) and provide attic ventilation</p> |
| Concealed ceiling rafters: insulation | <p>Verify the presence of insulation for the full rafter depth. If not present, consider not providing lending assistance; otherwise, lending assistance; otherwise, engage the services of a licensed architect or engineer to design the installation of additional insulation, a concealment structure (i.e. drop ceiling), & structure any necessary ventilation.</p> | <p>Verify the presence of for the full depth of rafters. present, consider not engage the services of a architect or engineer to the installation of additional insulation, a concealment structure (i.e. drop ceiling), and any necessary ventilation.</p> |
| | <u>Direct Loan Program</u> | <u>Guarantee Loan Program</u> |
| Accessible floors with insulation: | <p>Insure the vapor barrier is located on the warm (top) side side of the insulation material and verify a minimum insulation resistance of R=19. If the vapor vapor barrier is incorrectly installed, installed, replace it and the insulation material with a vapor barrier material installed on the warm side of new insulation material. Upgrade new insulation material, if necessary, necessary, to minimum R=19.</p> | <p>Insure the vapor barrier is located on the warm (top) of the insulation material and verify a minimum insulation resistance of R=19. If the barrier is incorrectly replace it and the insulation material with a vapor barrier installed on the warm side of insulation material. Upgrade insulation material, if necessary, to minimum R=19.</p> |

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| Crawlspace areas under floors with no insulation: | <p>The top 2 feet of the concrete "Band-joist"* areas should be insulated at minimum R=19 and insulated at minimum R=10; water piping system components "rim-joist" areas should be insulated at minimum R=19; and provide minimum crawlspace ventilation requirements****</p> |
|---|--|

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| Basement areas under floors with no insulation: | <p>The top 4 feet of the concrete "Band-joist"* areas should be insulated at minimum R=19 and insulated at minimum R=7.5 water piping system components and "rim-joist"* areas should be insulated to prevent pipe freezing.</p> |
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| Exterior walls: (Program) | <p>Verify actual existing insulation (Same as Direct Loan conditions. Uninsulated or very poorly insulated walls around heated spaces would pose high energy bill and possible pipe freezing conditions. Upgrading wall insulation might be necessary, but only cost effective on a large scale if wall framing were to already be exposed for another reason.</p> |
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|-----------------------|---|
| Windows: (Program) | <p>Provide as least two panes (Same as Direct Loan of glass, by whatever method is most feasible.</p> |
|-----------------------|---|

| | |
|----------------------------|-------------------------------|
| <u>Direct Loan Program</u> | <u>Guarantee Loan Program</u> |
|----------------------------|-------------------------------|

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|-----------------|--|
| Exterior doors: | <p>Target providing a solid core (Same as Direct Loan Program) door plus a storm door or providing a metal-faced, insulated core door. In either case a good weather-stripped seal should also be present.</p> |
|-----------------|--|

* "Rim-joist" = "band-joist" = "band beam" = framed area above the concrete foundation wall and the bottom of first floor sheathing.

** WHDD = Winter Heating Degree Days: Reference the Thermal Map for the State of Colorado provided as Exhibit F to this AN.

*** Minimum attic ventilation requirements (net free ventilation area in vents):

| | |
|-------------------------------------|----------------------|
| Soffit vents only: | = 1/150 x attic area |
| Ridge vents only: | = 1/150 x attic area |
| Gable end vents only: | = 1/150 x attic area |
| Combination soffit and ridge vents: | = 1/300 x attic area |

**** Minimum crawlspace ventilation requirements (net free ventilation area in vents):

No vapor barrier on crawlspace floor: = $1/150 \times$ crawlspace floor area

Vapor barrier on crawlspace floor: = $1/1,500 \times$ crawlspace floor area

COUNCIL OF AMERICAN BUILDING OFFICIALS (CABO)
MODEL ENERGY CODE
1992 EDITION

The CABO Model Energy Code, 1992 Edition, or "MEC-92", as commonly referred to within the Agency, was introduced as the intended thermal performance regulation for Section 502 new "stick-built" and "modular" construction, effective October 23, 1993, by the Cranston-Gonzalez National Affordable Housing Act for the purpose of standardizing thermal performance regulations among the USDA, HUD, and VA.

It is about a ninety page document intended, per CABO, for

"....the design of residential building envelopes for adequate thermal resistance and low air leakage and the design and selection of mechanical, electrical, service water-heating and illumination systems and equipment which will enable effective use of energy in new building construction."

It is, therefore, really a total energy system regulatory concept and is much more comprehensive than the *"Thermal Performance Construction Standards"* contained in Rural Development Instruction 1924-A, Exhibit D. It addresses the following energy-related aspects of residential construction: wall/roof/floor thermal insulation, air leakage, humidity control, thermostatic control, recovered energy, mechanical heating plants, mechanical cooling systems, duct insulation, piping insulation, heating volume controls, water conservation, illumination systems, water heaters, and even swimming pool covers.

Design verification of compliance with the MEC-92 is accomplishing by the completion of Form RD 1924-25, *"Plan Certification"* by a non-Agency consultant.

COOLING DESIGN REQUIREMENTS

Though the more frequent climate control demand in Colorado is heating, some areas do warrant the integration of air-conditioning into new construction due to the length of the cooling season. Typically these areas occur at the lowest elevations. Air-conditioning is considered an eligible funding purpose for SFH Programs project construction in Colorado only at locations exceeding 600 cooling degree days. This is considered to be a reasonable compromise between cost containment and market driven demands. Reference Exhibit B to this ATG for more detailed information on locations where air conditioning is considered an eligible funding purpose in Colorado.

USDA/RURAL DEVELOPMENT EMPLOYEE RESPONSIBILITIES

Agency personnel involved with Single Family Housing loanmaking should become reasonably familiar with the thermal certification requirements discussed earlier so as to be able to direct technical inquiries from customers and lenders. It is not intended that USDA/Rural Development employees should advise/direct customers and builders with regard to what thermal-related products should be utilized. Neither should USDA/Rural Development employees perform thermal performance verification calculations. The whole purpose of using MEC-92 is to allow builders the flexibility to select suitable building products which comply with a preselected national energy standard. Likewise, the purpose of the thermal performance certification process is to alleviate the need for lengthy oversight by agency personnel.

The State Architect should be consulted with respect to any questions on this subject.

DAVID W. RIGIROZZI
State
USDA/Rural Development

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|--------------|------------|---|
| Attachments: | Exhibit A: | Winter Heating Degree Day Map for Colorado |
| | Exhibit B: | Permissible Locations in Colorado for Financing Air Conditioning in SFH Programs New Construction |

Winter Heating Degree Days Zones in Colorado

[Reference the attached “*Winter Heating Degree Days for Locations throughout Colorado*” chart]

Heating degree days and cooling degree days are used as a measure of the heating and cooling needs of buildings. Both are referenced to 65 degrees F. If the average of a given day's high and low temperature is 65 degrees, then there are no (zero) heating or cooling degree days. If the average temperature is 72 degrees F for a given day, then there are (72 minus 65 equals) 7 cooling degree days. If the average temperature is 50 degrees F., then there are (65 minus 50 equals) 15 heating degree days. You can add up the degree days for any time period, say the month of January, and get an idea of how much heating is required to heat buildings. The energy industry pays close attention to heating and cooling degree days as a way to predict energy prices.

Colorado climate control demands are biased more toward the heating season than the cooling season for all locations. More severe heating demands are related to higher elevations above sea level, more northerly longitudinal locations, and other climatic influences. They are effectively addressed in Rural Development regulations by location 6001+ heating degree days construction criteria. Typically, a change in elevation of 1,000 feet in Colorado correlates to about a 4-degree Fahrenheit change in temperature. RD Instruction 1924-A, Exhibit D, “*Thermal Performance Construction Standards*”, maximum U values for ceiling, wall, and floor assemblies in SFH existing construction are bracketed into 2 heating degree day zones for Colorado, 4501 to 6000 areas and 6001+ areas. The following heating degree days chart highlights the most severe zone **(6001+) reference locations in red.**

[The following data has been furnished by the National Weather Service.]

Winter Heating Degree Days

For Locations throughout Colorado

| COLORADO LOCATION | HEATING DEGREE DAYS |
|----------------------------|---------------------|
| Akron | 6620 |
| Alamosa | 8749 |
| Altenbern | 7102 |
| Antero Reservoir | 11033 |
| Bailey | 8944 |
| Blanca | 8759 |
| Bonny Dam | 6216 |
| Boulder | 5554 |
| Briggsdale | 6803 |
| Buena Vista | 8003 |
| Burlington | 6320 |
| Byers | 6473 |
| Canon City | 4987 |
| Castle Rock | 6932 |
| Center | 8968 |
| Cheesman | 7820 |
| Cherry Creek Dam | 6343 |
| Cheyenne Wells | 5925 |
| Cimarron | 8719 |
| Climax | 12684 |
| Cochetopa Creek | 10116 |
| Collbran | 7363 |
| Colorado National Monument | 5799 |
| Colorado Springs | 6415 |
| Cortez | 6667 |
| Crested Butte | 11292 |
| Del Norte | 7980 |
| Delta | 5927 |
| Denver | 6020 |
| Dillon | 11218 |
| Dinosaur National Monument | 7250 |
| Evergreen | 8094 |
| Flagler | 6280 |
| Fort Collins | 6368 |
| Fort Lewis | 8074 |
| Fort Morgan | 6460 |
| Fruita | 6247 |
| Gateway | 5267 |

| COLORADO LOCATION | HEATING DEGREE DAYS |
|--------------------------|----------------------------|
| Glenwood Springs | 7313 |
| Grand Junction | 5620 |
| Grand Lake | 10605 |
| Grant | 9777 |
| Great Sand Dunes NM | 7887 |
| Greeley | 6306 |
| Green Mountain Dam | 9248 |
| Gunnison | 10516 |
| Eads | 6129 |
| Hayden | 8403 |
| Hermit | 11375 |
| Holly | 5588 |
| Holyoke | 6583 |
| John Martin Dam | 5603 |
| Julesburg | 6447 |
| Kassler | 6243 |
| Kit Carson | 6372 |
| Kremmling | 10095 |
| La Junta | 5265 |
| Lake City | 9569 |
| Lake George | 10022 |
| Lakewood | 6158 |
| Lamar | 5414 |
| Las Animas | 5455 |
| Leroy | 6683 |
| Longmont | 6443 |
| Manasa | 8375 |
| Meredith | 9922 |
| Mesa Verde NP | 6432 |
| Maybell | 8765 |
| Monte Vista | 9003 |
| Montrose | 6383 |
| New Raymer | 6672 |
| Northdale | 7401 |
| Norwood | 7643 |
| Ordway | 6326 |
| Ouray | 7639 |
| Palisade | 5152 |
| Paonia | 6350 |
| Pueblo | 5413 |
| Rocky Ford | 5289 |
| Rangely | 7328 |

| COLORADO LOCATION | HEATING DEGREE DAYS |
|--------------------------|----------------------------|
| Rico | 9585 |
| Rifle | 6881 |
| Rush | 7222 |
| Ruxton Park | 10778 |
| Salida | 7355 |
| Saguache | 8781 |
| Sedgwick | 6221 |
| Silverton | 11064 |
| Spicer | 10469 |
| Steamboat Springs | 9779 |
| Sterling | 6541 |
| Stratton | 6405 |
| Taylor Park | 12006 |
| Telluride | 8986 |
| Trinidad | 5339 |
| Twin Lakes | 10896 |
| Uravan | 5726 |
| Vallecito Dam | 8248 |
| Walden | 10378 |
| Walsenburg | 5438 |
| Waterdale | 6648 |
| Westcliffe | 8318 |
| Wolf Creek Pass | 11169 |
| Wray | 6160 |
| Yampa | 9316 |
| Yellow Jacket | 6889 |
| Yuma | 5890 |

Exhibit B

Architectural Technical Guide 0016

(Revised 01/01/05)

Permissible Locations in Colorado for Financing Air Conditioning in SFH Programs New Construction

Permissible Locations in Colorado for Financing Air Conditioning in SFH Programs New Construction

[Reference the attached “*Cooling Degree Days for Locations throughout Colorado*” chart]

Heating degree days and cooling degree days are used as a measure of the heating and cooling needs of buildings. Both are referenced to 65 degrees F. If the average of a given day's high and low temperature is 65 degrees, then there are no (zero) heating or cooling degree days. If the average temperature is 72 degrees F for a given day, then there are (72 minus 65 equals) 7 cooling degree days. If the average temperature is 50 degrees F., then there are (65 minus 50 equals) 15 heating degree days. You can add up the degree days for any time period, say the month of January, and get an idea of how much heating is required to heat buildings. The energy industry pays close attention to heating and cooling degree days as a way to predict energy prices.

Though the more frequent climate control demand in Colorado is heating, some areas do warrant the integration of air-conditioning into new construction due to the length of the cooling season. Typically these areas occur at the lowest elevations. Air-conditioning is considered an eligible funding purpose for SFH Programs project construction in Colorado only at locations exceeding 600 cooling degree days. This is considered to be a reasonable compromise between cost containment and market driven demands. The following cooling degree days chart highlights **600+eligible reference locations in blue.**]

[The following data has been furnished by the National Weather Service.]

Cooling Degree Days

For Locations throughout Colorado

| COLORADO LOCATION | HEATING DEGREE DAYS |
|--------------------------------|---------------------|
| Akron | 695 |
| Alamosa | 69 |
| Allenspark | 26 |
| Aspen | 36 |
| Bonny Dam | 919 |
| Boulder | 790 |
| Buena Vista | 76 |
| Burlington | 887 |
| Byers | 648 |
| Canon City | 919 |
| Cedaredge | 510 |
| Center | 76 |
| Cheesman | 180 |
| Cherry Creek | 554 |
| Cheyenne Wells | 921 |
| Cochetopa Creek | 13 |
| Colorado National Monument | 1069 |
| Colorado Springs | 501 |
| Cortez | 473 |
| Crested Butte | 0 |
| Del Norte | 41 |
| Denver | 680 |
| Dillon | 0 |
| Durango | 209 |
| Eads | 1066 |
| Eagle | 119 |
| Estes Park | 29 |
| Fort Collins | 471 |
| Fort Lewis | 79 |
| Fort Morgan | 760 |
| Fruita | 754 |
| Glenwood Springs | 371 |
| Grand Junction | 1205 |
| Grand Lake | 0 |
| Great Sand Dunes National Park | 111 |
| Greeley | 647 |
| Green Mountain Dam | 56 |
| Gunnison | 18 |

| | |
|---------------------------------|------|
| Hayden | 154 |
| Hermit | 0 |
| Holly | 1283 |
| Holyoke | 825 |
| John Martin Dam | 1304 |
| Kassler | 713 |
| Kauffman | 431 |
| La Junta | 1301 |
| Lakewood | 639 |
| Lamar | 1242 |
| Las Animas | 1226 |
| Little Hills | 116 |
| Longmont | 555 |
| Mesa Verde National Park | 596 |
| Monte Vista | 77 |
| Montrose | 581 |
| Northdale | 227 |
| Norwood | 143 |
| Ouray | 105 |
| Pagosa Springs | 86 |
| Palisade | 1290 |
| Parker | 460 |
| Pueblo | 1042 |
| Rangely | 575 |
| Rifle | 345 |
| Rocky Ford | 1008 |
| Rye | 295 |
| Saguache | 86 |
| Silverton | 0 |
| Steamboat Springs | 18 |
| Sterling | 721 |
| Stratton | 901 |
| Taylor Park | 0 |
| Telluride | 0 |
| Trinidad | 741 |
| Vallecito Dam | 70 |
| Walden | 0 |
| Walsenburg | 538 |
| Waterdale | 410 |
| Westcliffe | 46 |
| Wray | 977 |